School of Science and Mathematics

Student Research Poster Display

Caputo Hall Lobby

April 22—29, 2015

• Biology •

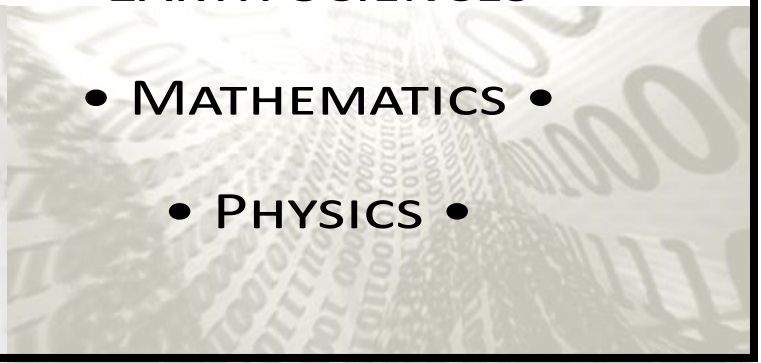
•CHEMISTRY•

• COMPUTER SCIENCE•

• Earth Sciences •

• Mathematics •

• Physics •



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Note: The names of Millersville University faculty advisors are designated by an asterisk (*) in the abstracts.

Biology

1. Characterizing the Venom of Ratfish

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Ratfish, a group of cartilaginous fishes related to sharks, are thought to possess venom originating in glandular epithelium located in a posterior groove on their dorsal spines. Individuals wounded by the spine experience a drop in blood pressure, and studies demonstrate that spine extracts cause death in mice. However, while substantial research has been conducted on related venomous organisms, such as stingrays, comparatively little research has been completed investigating the characteristics of extracts retrieved from the spines of ratfish. This preliminary study aims to characterize the venom of ratfish through tissue scraping, protein assay, and high performance liquid chromatography (HPLC). Initial assays indicate the presence of proteins, and chromatograms suggest the presence of several compounds in extracted tissue.

This project was supported by a CPUB grant.

2. Identification of Areas Baited for Wildlife Using Chemical Analyses

Griffin, Meta (MU 2014); Conrad, Tristan (MU 014); Fetterolf, Angela; Haines, Aaron; Kennedy, Steven*
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Supplemental feeding and baiting of white-tailed deer has the potential to increase the spread of diseases such as Chronic Wasting Disease. Also, the baiting of wildlife for harvest is illegal in Pennsylvania. The objective of this study was to determine if commercial deer baits leave a chemical signature in the soil which is detectable through chemical analysis. This information could be used by wildlife officers to determine if an area was illegally baited. Commercial deer baits were applied to experimental soil patches and compared to non-baited soil patches. The commercial baits that were used in this experiment included '3 Day Harvest' by C'Mere Deer®, 'Acorn Rage JUICED' by Wildgame Innovations, and 'Deer Cane' mix by Evolved Habitats Wildlife Nutritional Products®. It was hypothesized that baited areas would exhibit higher concentrations of calcium, sodium, and chloride compared to non-baited soil areas. Atomic absorption spectroscopy was used to measure the amount of sodium and calcium ions and a chloride probe was used to measure chloride ions. Results of this experiment showed that for both 'Deer Cane' and 'Acorn Rage JUICED', the presence of both Sodium and Chloride ions were adequate indicators of baiting activity compared to non-baited sites. However, for '3 Day Harvest' by C'Mere Deer®, we observed no differences in the levels of sodium, calcium and chloride ions between baited and non-baited sites. Further study is needed to find less expensive ways of testing for these chemical ions, so that wildlife officers can easily determine if a site has been baited illegally.

Biology

3. Cognitive Behavior after Tropisetron Treatment in Estrogen-Primed Female Rats
*Hassell, Joel and Maswood, Sharmin**
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We are evaluating the effects of a memory enhancing drug, tropisetron, in ovariectomized (ovaries removed) female rats primed with estrogen using the object recognition task. The object recognition task is a model of cognition in rodents in which the natural tendency of rats to explore novel aspects of the environment is utilized. Rats spend more time exploring the novel object, suggesting that rats recognize previously explored objects. Earlier studies show that either estrogen alone or treatment with drugs such as tropisetron enhances object recognition in female rats. We are looking at the combined effects of both estrogen priming and tropisetron treatment in female rats. Our data show that in comparison to rats receiving no estrogen, rats primed with 20 µg of estrogen show an increase in cognition. Furthermore, rats primed with 20 µg of estrogen and injected with 2.5 mg/Kg tropisetron show the greatest enhancement in cognitive behavior. Findings from this research will provide information to identify the mechanisms involved in estrogen's enhancement of cognitive functions; this will also explain the cognitive decline associated with menopause and Alzheimer's disease in females.

4. Radio-telemetry Tracking of *Phasianus colchicus* at Safe Harbor Nature Preserve, Safe Harbor, Pennsylvania: A Pilot Study.
*Isabella, Amanda and Haines, Aaron M.**
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Phasianus colchicus, or ring-necked pheasants, have been an important gamebird species since their introduction to the United States from Asia. They can also be used to help determine conservation reserve success in areas with high farm density, such as Lancaster County. Six ring-necked pheasants were released at Safe Harbor Nature Preserve in Safe Harbor, Pennsylvania and subsequently tracked for one week using VHF radio-telemetry. Tentative home range size and mortality rates of the pheasants will be analyzed to determine the feasibility of using the tracking of ring-necked pheasants as a teaching tool for undergraduate students. Results are still being collected from the field. If this pilot study determines that such a tracking project is feasible with undergraduate students, then pheasant tracking will be incorporated within a Topics Course in Ecology Field Methods at Millersville University. The purpose of this course will be to better train and retain biology students at Millersville University for careers in environmental biology.

Biology

5. Comparative Genomic Analysis Reveals Potential Sex-specific Genetic Sequences in Doryteuthis pealeii

*Kahn, Saqib; Acevedo, Lindsey; Neugebauer, Jessica (MU 2013); Hepfer, Carol Ely**
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Investigations of the longfin inshore squid, Doryteuthis pealeii, have provided important information about nerve function, muscle physiology, animal behavior, and the physics of jet propulsion. In spite of this, very little is known about the genetics of this organism, and their mechanism for sex determination remains a mystery. Since the ratio of males to females born is consistently 1:1 despite changes in environment, it is likely that genes control their sexual development. To determine if genetic differences exist between males and females, we used Amplified Fragment Length Polymorphism (AFLP) analysis. This PCR-based technique can be used effectively to compare entire genomes when no DNA sequence information is available. Preliminary results have revealed many sex-specific differences in AFLP banding patterns. Further analysis of these differences should lead to the isolation of genes that play important roles in sex determination in this squid species.

6. Identification of Research Needs for Wildlife Law Enforcement

*Meshe, Folake and Haines, Aaron M.**
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Wildlife law enforcement has been a tool used to conserve and protect wildlife species threatened by negative anthropogenic effects since the early 1200's in England, and continues to be implemented in our societies today. Many times, wildlife law enforcement is just as important as research and management when preserving wildlife populations. We developed a survey to pinpoint areas of needed research for wildlife law enforcement agencies. We sent out this survey to all 50 state wildlife law enforcement agencies in the United States and several provincial wildlife law enforcement agencies in Canada. Our goal is to identify the research needs of wildlife law enforcement officers and identify more effective strategies to mitigate wildlife crime. Survey results are currently being compiled and analyzed. Information revealed from these survey results will be used to promote wildlife law enforcement research needs.

7. Reducing Anxiety Related Symptoms in Domesticated Cats

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In a veterinary setting, many cats show physiological signs of stress and anxiety, which can be harmful to the animals and to the people restraining them. Stress and anxiety can also make diagnosing illnesses more difficult because of the cat struggling or showing aggression towards their owner or the veterinarian. Tranquilizers or sedatives are sometimes used, but some cats cannot tolerate them because of advanced age or poor health. Many brands of calming sprays claim to reduce anxiety during veterinary visits or other anxiety producing situations. In the first experiment, two common brand name sprays were tested for their effectiveness in reducing anxiety: (1) Nature's Miracle No Stress Calming Spray, and (2) Comfort Zone Spray with Feliway for Cats. Ten household cats experienced a mock veterinary examination after exposure to each one of the odors and to a tap water control. Results showed that only Feliway reduced heart rates relative to the control. In the second experiment, the chemical components of both Feliway and Nature's Miracle were systematically examined to test their effectiveness in reducing anxiety: (1) Feliway, (2) Nature's Miracle, (3) 5% propylene glycol, (4) 90% ethanol, (5) preservatives other than propylene glycol (found in Nature's Miracle), (6) isolated feline facial pheromone, and (7) tap water (control). Herbal extracts found in Nature's Miracle were not tested because of propriety restrictions. 180 cats were handled similarly to the first experiment (30 per treatment; all cats received the control). Results showed that both Nature's Miracle and Feliway reduced heart rates; however, ethanol and propylene glycol were equally effective and no other tested ingredients contributed significantly to the reduction in heart rates. Results indicate that commonly available chemicals are equally effective to these brand name sprays at reducing stress in domesticated cats.

8. Microbial Diversity on Surfaces of Wrestling Equipment

*Sarver, Dylan and DiBartolomeis, Susan**
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The aim of this study is to uncover the microbial environments of wrestler's athletic equipment and to direct proper cleaning procedures to minimize pathogenic microbial numbers. Surface samples were collected onto nutrient rich agar plates from wrestling equipment, such as headgear, wrestling shoes, mats, and various exercise equipment. Bacterial species were isolated and identified by sequencing their 16S rRNA genes and comparing hyper-variable regions to a gene base of 16S rRNA sequences. Fungal species were identified via morphological uniqueness after isolation and incubation on Sabouraud agar and chloramphenicol plates. Pathogenic microorganisms found were tested against cleaners to test cleaner efficacy. The microbial environments found on wrestling equipment are likely the reason for the high skin disease rate in this sport. Using specific cleaners for different wrestling equipment might help to decrease the number of pathogenic microbes found on said equipment.

Biology

9. Plastron Formation by Neural Crest Cell Migration

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The bones of the underside of turtle shell have been shown to be formed by neural crest cells (NCC), a migrating population of cells that is capable of differentiating into many different types of cells. Previous work has also demonstrated that the NCC migrate in two waves away from the neural tube in turtle embryos, instead of a single migration as is seen in other vertebrate embryos. These unique trunk neural crest cells in turtle embryos are also able to form cell types, such as bone, that are restricted to the head in other model organisms. The purpose of my project is to identify the cell types formed from early and late migrating NCC in the trunk of the turtle embryo using cell culture and antibody staining. The pattern produced by each type of neural crest cell will be compared to the cell types that cranial NCC form, to determine if late migrating trunk neural crest cells are similar to cranial NCC in their cell differentiation capabilities.

Chemistry

10. Synthesis and Characterization of Gold Nanocages for Use in Catalysis and Microbial Identification

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Gold nanostructures have been providing the world with versatile biological and catalytic applications. Specifically, gold nanocages, have been put under intense investigation for their current uses in targeted drug delivery, cancer diagnosis, and imaging. Normally, gold nanospheres in a specific size range of 3-20 nanometers are used for catalysis of known organic reactions due to their high surface to volume ratio. Gold nanocages have an even greater surface to volume ratio than spherical nanoparticles due to their porous nature, thus may be able to catalyze the same reactions more efficiently. For the biological application, by taking advantage of the fact that gold has a high affinity for sulfur, it is reasonable to add a thiolated 16s rRNA probe onto a gold nanocage thin film prepared by evaporation enhanced deposition to a glass microscope slide. The probe will bind to a microbe's 16s transcript that will allow us to identify its species by monitoring the change in the gold's surface plasmon resonance. The goal of the project is to synthesize porous gold nanocages from silver nanocubes, and nanospheres through galvanic replacement and compare catalytic and microbial results against spherical nanoparticles.

11. Studies Toward the Synthesis of Hunanamycin A and its Derivatives

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Studies toward the synthesis of Hunanamycin A (HA) have recently been initiated. HA is a natural product isolated in small quantities (< 1 mg) from *Bacillus hunanensis*. It exhibits antibacterial activity for various pathogens such as *Salmonella* and *E. coli.* At the onset of this research project, conceivable synthetic routes to HA were designed based on related literature precedents for each planned reaction of the route. Currently, test reactions (*e.g.* nitration, reductive amination, and amine acylation) are being optimized on model systems to explore multiple pathways of producing the target product, along with structurally similar derivatives, via chemical synthesis. Once an efficient route is elucidated, further biological testing of synthetic HA, and related derivatives, could allow for a calculated modification of the antibacterial properties displayed by this class of molecules. Our most progressive route to date employs a reductive amination method to provide a prenylated amine intermediate in moderate yield over multiple steps from commercially available and relatively inexpensive starting materials.

Chemistry

12. Synthesis of Variable Size Nanoprisms for Application in Signal Enhancement Using Raman Spectroscopy

*Keller, Taylor M. and Schiza, Maria V.**
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Silver nanoparticles encompass conductive, thermal, optical, and antibacterial properties that can be used in many applications. Examples of these applications include the following: inks, paints, footwear, wound dressings, cosmetics, and biosensors. The nanoparticle properties depend highly on their size. Thus, the way of synthesis and characterization of these particles is very important. Sizes of those particles can be estimated based on their absorbance wavelengths and can be verified by using electron and probe microscopy. In our research we aim to synthesize different size silver nanoprisms and apply those to the enhancement of analyte signal using Surface Enhanced Raman Spectroscopy (SERS). While most nanoparticles are spherical in shape, the prismatic shapes of nanoprisms provide more surface area and edges that could aid in analyte signal enhancement using SERS. Once the nanoprisms are prepared, their size and shape can be estimated using UV-visible spectroscopy and Transmission Electron Microscopy (TEM). The different size nanoprisms are then used to show signal enhancement using Raman Spectroscopy.

13. Studies Toward the Synthesis of Altersolanol P

*Smaligo, Andrew J.; Hensinger, Magenta J.; Kennedy, Steven M.**
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We have recently initiated studies toward the synthesis of altersolanol P (AP), a naturally occurring tetrahydroanthraquinone recently isolated from forest leaf litter collected at the Caribbean National Forest in Puerto Rico. AP exhibits broad-spectrum Gram-positive antibacterial activity, as well as strong activity against the Gram-negative bacteria, Haemophilus influenza. Retrosynthetic analysis led us to explore the possibility of a Diels-Alder cycloaddition as a method to produce a synthetic intermediate containing the complete carbon framework of the target molecule. From the desired adduct, AP could conceivably arise from a sequence of alkene isomerization, followed by dihydroxylation. Currently, we are conducting a methods study in order to learn about the regioselectivity of Diels-Alder reactions under various conditions. Our long–term goal is to craft an efficient route to altersolanol P, and its derivatives, so that its biological activity can be further explored.

Chemistry

14. Construction of a His-tagged expression plasmid for SfnaD in the staphyloferrin A biosynthetic pathway

*Tran, Tan and Kittleman, William**
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The purpose of this research is to produce a His-tagged expression plasmid for the production of SfnaD, a **n**onribosomal peptide synthetase **i**ndependent **s**iderophore (NIS) enzyme involved in the biosynthesis of staphyloferrin A (SfnA). SfnA is one of two iron-binding siderophores produced by *Staphylococcus aureus*, a gram-positive bacterium responsible for numerous types of infections including those of the skin, heart, and bone. SfnaD catalyzes amide bond formation between D-ornithine and citrate in the second step of the SfnA biosynthetic pathway. Inhibition of this enzyme could result in reduced iron uptake in *S. aureus* and reduced virulence, making SfnaD a potential new drug target. This research presents progress towards construction of the expression plasmid for the SfnaD enzyme. This enzyme will be overexpressed, purified, and used in *in vitro* inhibition studies. A potential mechanistic-based inhibitor is also presented.

Computer Science

15. Using the MYO Armband to Manipulate a 3D Environment

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In this study we investigate the MYO armband (https://www.thalmic.com/en/myo/), a band worn around the forearm that recognizes gestures using electromyography (EMG). The band includes a development kit that allows custom applications to be built that respond to gestures. For example, a music player could allow music to be played when you spread your fingers and stopped when you make a fist. The goal of the study is to be able to use the MYO armband to control a character in a 3D game world. Gestures will allow the character to move and manipulate objects. We have been able to use Lua scripts to allow gesture recognition in some desktop applications, but using the MYO to control a game character has necessitated writing C++ code for more precise interactions with the band.

16. Implementing a Concurrent-by-Default Programming Language with Automatic Memoization

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The number of cores in desktop and mobile processors continues to rise, as do the resource demands of the applications which run on them. As these trends continue the need for non-linear execution of programs also increases. Hand parallelization of computer programs is time consuming, error prone, and tedious. On the other hand, automatic parallelization of existing programming languages is a extremely difficult problem. We implemented an optimizing compiler for a simple, purely declarative programming language, Hydrogen, which was able to automatically parallelize source inputs to produce concurrent programs. Applying parallel optimizations to code naively often increases execution time, so this provided the opportunity to implement and compare several different heuristics using computed weights and the call flow graph of the source program to determine when it was appropriate to apply parallelization as well as other optimizations.

Computer Science

17. Optimization of Restricted Random Walk Simulation

*Waegel, Graham and Zoppetti, Gary M.**
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The goal of this study is to write and optimize a simulation for random walks on a restricted lattice. Generally, the random walk problem consists of a walker taking steps in random directions on an infinite Cartesian lattice, and a common question is to find the probability of returning to the origin. This study examines a variation on this problem in which links on the lattice have been randomly removed to restrict the walker's movement. The simulation generates useful statistical results for the return probability by running thousands to millions of trials, which requires significant processing time. This is especially intensive for walks of many steps or higher dimensions, and the addition of movement restriction poses further complications for efficient computation. For optimization, we have written a modular simulation with multiple interchangeable implementations that we then compare to find which gives the greatest performance. We also plan to implement parallel processing with multithreading and multiple machines, which is well suited for the repetitive nature of the problem and introduces further room for optimization.

18. Effects of wildfire pollution on the microphysical and electrical properties of pyrocumulus

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Pyrocumulus clouds form over wildfires when hot, smoke-filled air rises, cools and condenses. These smoke-polluted clouds have higher cloud condensation nuclei (CCN) concentrations, which affect their microphysical and electrical properties. Lightning generation processes in pyrocumulus are not well understood, but have implications for wildfire growth predictions and the radiative and chemical characteristics of the upper troposphere (Lang et al. 2014). Lang et al. (2014) documented an electrified pyrocumulus over the May 2012 Hewlett Gulch fire outside of Fort Collins, Colorado, which produced approximately twenty intracloud lightning flashes. Motivated by their work, we investigate the microphysical differences between low CCN clean clouds and high CCN pyrocumulus. Model simulations were made of a cloud forming under five different CCN concentrations, ranging from clean to extremely polluted. Moderately polluted pyrocumulus experience a complete shutdown of rain processes and an increase in graupel production. In extremely polluted pyrocumulus, however, graupel production is halted, which allows for large amounts of liquid water and small ice. Using these microphysical details, a possible charging mechanism will be inferred and compared to Lang et al. (2014). The main goal is to better understand the aerosol-induced cloud-scale microphysics that causes pyrocumulus electrification to occur.

Mathematics

19. In-Class Practices of Flipped Mathematics Educators

*Eisenhut, Lindsay and Taylor, Cynthia E.**
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The flipped classroom, also known as the flipped learning model, has become increasingly popular over the last several years. Interest in the model has grown, in part, due to mathematics educators searching for ways to improve students' mathematical proficiency and conceptual understanding. While there is an abundance of preliminary evidence regarding the impact that flipped learning has on mathematics classrooms (Goodwin & Miller, 2013; Hamdan et al., 2013, Vaughan, 2014; Yarbro et al., 2014), the authors of Principles to Actions (NCTM, 2014) point out that there is currently no consistent scientific evidence suggesting that the flipped classroom has an impact on student learning. As such, it is critical that meaningful research is made available to the flipped learning community. This study aims to gain a better understanding of how grade 7-12 mathematics teachers maximize the use of class time in a flipped classroom. The qualitative results of this study provide a detailed description of the types of tasks grade 7-12 mathematics teachers facilitate in flipped classrooms, as well as their purposes for choosing the identified tasks. Furthermore, the data may be used to inform mathematics educators of various ways their peers have chosen to structure class time in a flipped classroom.

Physics

20. X-ray Spectroscopy of Supernova Remnant 0519-69.0

*Baldree, William and Hendrick, Sean**
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Supernova Remnant 0519-69.0 is one of the youngest and brightest remnants in the Large Magellanic Clouds. Archival data from the *Chandra* X-ray Observatory is analyzed in this project. The X-ray spectrum consists of several sharp and bright spectral lines that are difficult to fit with current models. Images of the remnant have been created at the energies corresponding to each line to examine the distribution of the elements in the remnant. Spatially-resolved spectroscopy has been used to examine and model the X-ray emission in various regions of the remnant.

21. Chandra X-Ray Analysis of Supernova Remnant 0506-68.0

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Supernova Remnant 0506-68.0, also known as N23, is a morphologically complex supernova remnant in the Large Magellanic Cloud. A new analysis of *Chandra* X-ray Observatory data for N23 is undertaken to understand the morphology and evolutionary progress of the remnant. Modeling of SNR N23 using *vnei, vpshock,* and *vsedov* models is undertaken. Preliminary fits of the whole remnant using non-equilibrium ionization shock models: *vnei* and *vpshock* were performed. Fit results improved when specific regions of the target were analyzed with spatially-resolved spectroscopy. Chemical abundances in the various region of the remnant can be examined with this technique. The outermost region has been examined with a Sedov model which assumes a point explosion in a uniform medium. From the Sedov parameters, the explosion energy, mass of the swept up interstellar material, and the age of the remnant can be determined.

22. Return Probabilities of Random Walks on a Restricted Lattice

*Waegel, Graham and Nolan, Michael**
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The goal of this study is to examine the return probabilities of a random walk on a restricted lattice. Generally, the random walk problem considers the movement of a walker that takes random steps on an infinite Cartesian grid, or lattice, which may be in any number of dimensions. We are examining a modification of the random walk in which the movement of the walker is restricted by random removal of links from the lattice. This restriction of movement alters the walker's probability of return to the origin, based on the probability of link removal. The nature of this relationship is explored using computer simulations, checked against limited analytic solutions. We have obtained data for both two and three-dimensional walks, and found that link removal generally increased the return probability in each case. We plan to analyze the data further to extrapolate the end behavior of return probability for many steps, and compare these asymptotic values between the two and three-dimensional walks for various link removal probabilities.

Biology

23. Evolutionary conserved mechanism of epidermal appendage formation in tooth-like dermal structures of skates.

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Many vertebrates have structures associated with the skin that serves a variety of functions, including protection and thermal insulation. These structures, known as epidermal appendages, include teeth, scales, feathers and hair. The best-studied of these (teeth, feathers and hair) all begin as a thickened region of epithelium (a placode) that develops through an evolutionary conserved mechanism of cell-cell communication involving a set of secreted proteins including Sonic Hedgehog (shh), ectodysplasin, and members of the Wnt family. The most primitive epidermal appendages are thought to be the tooth-like dermal structures found in the skin of chondrichthyans (sharks, skates, rays, and chimaera), however, little is currently known at the molecular level about their development. Sonic hedgehog has been shown to regulate the outgrowth of feathers, teeth and hair in birds and mammals. To determine whether this mechanism was shared more broadly among the vertebrates, the expression of *shh* mRNA was examined through in situ hybridization of skate embryos at a range of developmental stages. Distinct spots of *shh* expression, consistent with developing placodes, were observed in the developing skate ectoderm. Another important signaling mechanism involved in epidermal appendage formation is the Wnt signaling pathway, leading to the nuclear localization of the beta-catenin transcription factor. The activation of the Wnt signaling pathway occurs at the stage of placode formation in developing hair follicles. To further characterize cutaneous appendage formation in skate embryos, the expression of beta-catenin is also being examined. Investigation of the similarities and differences between skin development in chondrichthyans and other vertebrates will give help to elucidate the evolution and diversity of epidermal structures.

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An asterisk (*) denotes the SCMA Faculty Advisor for the student research

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